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ILLINOIS NATURAL HISTORY SURVEY

Section of Wildlife Research

Illinois Forest Game Investigations

W-87-R-8

Quarterly Federal Aid Performance Report

by

Charles M. Nixon, Lonnie P. Hansen, James H. Witham, Jon W. Jones
Illinois Natural History Survey

1 January through 31 March 1987

QUARTERLY FEDERAL AID PERFORMANCE REPORT

Illinois Forest Game Investigations W-87-R-8

Charles M. Nixon, Illinois Natural History Survey, Champaign

Lonnie P. Hansen, Illinois Natural History Survey, Champaign

1 January through 31 March 1987

Study No. VII-D; Title: Harvest Strategies for Illinois Deer Herds

Job VII-D-1; Title: Population dynamics of the Illinois deer herd--current status, harvest analysis, and formulation of alternative management strategies.

The 1986 raw harvest data were received from IDOC, divided into counties, regions, statewide, refuges, and species areas and added to existing files in the University of Illinois Cyber computer. These files were then corrected and placed on diskettes for analysis on the Apple computer. A program disk to provide harvest analysis from the 1957-1986 harvest data and the updated harvest files for each county and region were then sent to the IDOC. Deer population modeling is now underway for each county and will be completed in the next quarter.

Job VII-D-2; Title: Life history and ecology of farmland deer.

Work continued on compiling and analyzing data collected during the Allerton study.

Job VII-D-3; Title: Strategies for developing and managing wintering sites for deer in central and northern Illinois.

A manuscript was prepared, reviewed, and submitted for publication. This manuscript summarized data that described the landscape characteristics of selected winter sites in east-central, west-central, and northern Illinois.

Job VII-D-4; Title: Data analysis and preparation of manuscripts and reports.

A manuscript was submitted to Wildlife Society Bulletin during the quarter:

Nixon, C.M., L.P. Hansen, and P. Brewer. Characteristics of winter habitats used by deer in central and northern Illinois.

Dr. Lonnie P. Hansen resigned from the project staff during the Quarter and accepted a position with the Missouri Department of Conservation as a deer biologist. Lonnie had worked for over 9 years on various projects funded as part of the cooperative Federal Aid Agreement between the Natural History Survey and the Illinois Department of Conservation.

QUARTERLY FEDERAL AID PERFORMANCE REPORT

Urban Deer Study-Illinois Natural History Survey

James H. Witham, Illinois Natural History Survey, Elgin
Jon M. Jones, Illinois Natural History Survey, Elgin

1 January through 31 March 1987

Study No. VII-D; Title: Urban Deer Study.

Job 104.1: Biology and ecology of urban deer

Fecal pellets were routinely collected during deer postmortem examinations performed during the study. During the fall quarter 1986, we subcontracted services of Mr. Jose Cisneros, a University of Missouri graduate student, to analyze 270 fecal samples for helminthic and protozoan parasites by the use of fecal flotation. Fecal samples from deer >1-year-old were stratified by location and season of collection. The final report by Cisneros is appended to this quarterly report (Cisneros 1987; Appendix A). Unfortunately, samples were frozen for periods that ranged from 1 to 3 years, which promoted the rupture of parasite eggs and oocysts. However, some valuable information resulted from this analysis. This information will serve as useful supplementary data to microhistopathological and toxicological analyses.

Mild conditions with limited snowfall typified winter weather for a second straight year. Conditions suitable for aerial surveys lasted for about 3 weeks. In addition, one week when snow conditions were suitable was lost because the Illinois Department of Transportation

helicopter was inoperable. Therefore, our original plan to conduct a complete helicopter survey of the 4-county study area, and to estimate precision of counts, was not possible.

Deer were counted for the fourth consecutive year in northern Cook County. These areas included the Ned Brown Preserve (Busse Woods), Des Plaines, Indian Boundary, Skokie, and North Branch Divisions in the Cook County Forest Preserve District (Table 1). Deer were surveyed on the same DuPage County Forest Preserves that were flown in 1985 (Table 2). Also, winter concentrations of deer were identified in Kane County during a 2-day survey by fixed-wing aircraft (Table 3).

The total number of deer counted in northern Cook County during 1987 was lower than counts made in 1986. Substantially fewer deer were observed in the Des Plaines Division (33% decline), the Indian Boundary Division (25% decline), the Ned Brown Preserve (38% decline), and the Skokie Division (18% decline).

With one exception, counts of deer in DuPage County were not remarkable. The exception was the Waterfowl Glen (2,434 ac)/Argonne National Laboratory (1,493 ac) complex east of Bolingbrook. Two-hundred seventeen white-tailed deer were counted on Waterfowl Glen, with an additional 30 observed on Argonne. In addition, 56 white fallow deer (Dama dama) were counted on Argonne. These counts may substantially underestimate the true number of the ungulates on these properties because: (1) some deer remain undetected during any survey, (2) Waterfowl Glen is partially composed of pine plantations, which obscure visibility relative to deciduous forests, and (3) the white fallow deer were exceptionally difficult to count against a snow

background. With these limitations, the density of ungulates counted (white-tails and fallow deer) was 49 deer/mi^2. The density of white-tailed deer on Waterfowl Glen alone was 57 deer/mi^2--the third highest density recorded during our 4-year-study.

Deer counts were made in Kane County by fixed-wing aircraft. One hundred ninety eight deer were counted during 2 days. Land use in Kane County west of the Fox River is dominated by agriculture. No deer were sighted in the relatively barren agricultural fields, which obviously provided little to no cover for deer during winter. All deer were sighted in, or adjacent to, woodlots. Major concentrations of deer were noted in north-northeast Kane County roughly parallel to Interstate 90 and west and south of Sugar Grove in southwestern Kane County.

We were greatly surprised by the amount of human development in seemingly rural Kane County. Recently developed residential subdivisions and large estates, most often adjacent to or within woodlots, were observed with surprisingly high frequency.

Modified postmortem examinations were performed on all deer collected under Job No. 104.3. These data will be summarized and contrasted with herd profiles that are currently being developed.

Job 104.2; Title: Deer range evaluation for metropolitan northeastern Illinois.

Not active this quarter.

Job 104.3; Title: Management strategies and implementation of experimental control of urban deer.

Records of deer-vehicle accidents that occurred in 1986 were collected from the municipalities of Barrington Hills, Bartlett, Des Plaines, Elk Grove Village, Hoffman Estates, and Rolling Meadows. Deer-vehicle accident records from the Cook County Sheriff's Police were generously provided by the Cook County Highway Department. These records are currently being summarized.

The same questionnaire used to determine the average cost of deer-vehicle accidents during 1984 and 1985 was sent to victims of deer-vehicle collisions investigated by the Cook County Sheriff's Police during 1986. Thus far, returns on the first mailing have been good and we are preparing a second mailing for non-respondents. Preliminary indications are that the average cost of a deer-vehicle collision in 1986 will exceed the $1,306 value determined from 1985 records.

We live-captured 22 deer during this quarter. Three of these deer were euthanized as part of the Busse Woods herd reduction program. The remaining 19 deer (males--5 fawns/3 yearlings/1 adult; females--6 fawns/1 yearling/3 adults) were translocated and released on the Fifth Army Training Area near Joliet. All females were instrumented with radio-collars; subsequent monitoring of these animals will supplement data previously collected on the survival and movements of translocated female deer. Males were ear-tagged with metal and plastic cattle tags only.

A late-winter sample of 12 deer from the Des Plaines River area was collected; data collected on productivity and condition will be contrasted with data collected previously.

We have continued to remove deer from the Ned Brown Preserve (Busse Woods) by live-trapping (N=14) and shooting (N=36) during this quarter. Postmortem examinations were performed on deer collected by shooting. When non-state funds were available, we continued the program on donating carcasses to the Greater Chicago Food Depository for processing and distribution to the needy of Chicago. We have donated a total of 52 deer to the Chicago Food Depository during fiscal year 1987.

Job 104.4; Title: Data base management, analysis, and reporting on urban deer research.

J.M. Jones gave a slide presentation on the Urban Deer Study to the Northeastern Illinois Geography Club. J.H. Witham and G.C. Sanderson participated in discussions with the IDOC on long-term management of urban deer herds in Chicago.

The INHS Urban Deer Study office received about 10 calls from private citizens that sought more information on urban wildlife. Professional biologists working with deer in Rockford (IL), Connecticut, and Colorado contacted the INHS Urban Deer Study office with questions on our research program.

One popular article, 1 symposium manuscript, and this quarterly report were prepared during this quarter.

Table 1. Numbers of deer observed on selected Cook County Forest Preserves during winter helicopter flights, 1985-1987.

Location	NUMBER OF DEER COUNTED[a]		
	1985	1986	1987
NED BROWN			
N of Higgins	207	154	85
S of Higgins	46	36	33
Totals	253	190	118
INDIAN BOUNDARY			
Madison to North	8	4	2
North to Belmont	0	0	0
Belmont to Irving Park	34	60	21
Irving Park to Lawrence	21	23	29
Lawrence to Kennedy Expwy	38	30	35
Kennedy Expwy to Devon	16	6	7
Devon to Touhy	13	9	5
Totals	130	132	99
DES PLAINS			
Touhy to Oakton	19	8	10
Oakton to Golf	21	21	13
Golf N to Central	30	25	28
Central N to Lake	53	106	91
Lake N to Palatine	60	53	29
Palatine N to Dundee	119	120	51
Dundee to Lake/Cook	73	53	47
Totals	375	386	269
NORTH BRANCH			
N of Oakton	13	8	4
S of Oakton	7	4	8
Totals	20	12	12
SKOKIE			
Tri State S to Voltz (west area)	46	69	42
Dundee to Lake/Cook	15	21	10
Dundee to Willow	54	71	92
Willow to Golf	12	46	26
Totals	127	207	170

[a]Counts from aerial surveys are minimum numbers of deer in a given area. They do not reflect absolute numbers because an indeterminable percentage of deer are not observed during a survey.

Table 2. The number of white-tailed deer observed in DuPage County Forest Preserves during 1985 and 1987 aerial censuses. Counts are minimum number of deer on preserves because an unknown percentage of deer were not sighted.

Forest Preserve	Number of deer counted	
	1985[a]	1987[b]
Blackwell	14	13
Burlington Park	0	0
Churchill Woods	0	2
Greene Valley	29	21
Herrick/Danada	6	19
Hidden Lake	7	13[c]
Morton Arboretum		19
McDowell Grove	0	1
Pratt's Wayne	2	11
Springbrook	0	0
Timber Ridge	19	19
Waterfowl Glen	71	217
Argonne		30 (+56 fallow deer)[d]
West Branch	23	22
West DuPage	3	0
Winfield Mounts	4	6

[a]16 February 1985, Cessna 172 fixed-wing aircraft.

[b]21-22 January 1987, Bell Long Ranger helicopter.

[c]Hidden Lake forest preserve & Morton Arboretum have adjoining boundaries.

[d]Argonne National Laboratory property adjoins Waterfall Glen forest preserve. Forested habitats on Waterfall Glen include patches of conifer plantations; our ability to observe deer in these sites was substantially made difficult because of snowcover.

Table 3. Numbers of deer observed in Kane County during winter fixed-wing aerial flights, 2-3 February 1987.

General location in Kane County	Number of deer counted
Northeast Kane County McQueens-Gilbert-Argonquin-Barrington Hills-Dundee	76
Northwest Kane County Near Rt. 20/I-90, north of Hampshire	17
Bowes S. to Rt. 64	6
Elburn S. to Sugar Grove, adjacent to Rt. 47	26
N. Aurora	1
Southwest Kane County S. and W. of Sugar Grove	72
Residential areas near Fox River	(did not count)
Total	198 deer

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APPENDIX A

Illinois Natural History Survey
Wildlife Section
Urban Deer Study

Helminthic and Protozoan Parasites of White-tailed Deer in Urban Areas of Northeastern Illinois

Final Report

Jose G. Cisneros, Investigator

January, 1987

Submitted to:
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Helminthic and Protozoan Parasites of White-tailed Deer in Urban Areas of Northeastern Illinois

Jose G. Cisneros

This report is part of the Urban Deer Study of the Illinois Natural History Survey. The project was a determination of the helminthic and protozoan parasites of white-tailed deer (Odocoileus virginianus) through fecal analysis. Animals sampled in this study are part of white-tailed deer herds found in urban locations of northeastern Illinois. Within the text is included detailed methodology, results of examinations, discussion of the significance of these results, and problems perceived in this study with recommendations for improvements.

METHODS

Over one thousand fecal samples were collected by Dr. James Witham during post mortem examinations of road killed white-tailed deer during a twenty-three month period (December 1983 to October 22, 1985). Samples were frozen and stored for a period of one to three years. For parasitological examination, 270 samples were chosen from four sites Northwest Cook County, Des Plaines, Busse Woods, and Non-Cook County. Within each location, samples were divided according to season collected - summer, fall, winter, and spring. All samples were from deer over one year of age.

Samples of feces were thawed for one hour before use and were processed for fecal flotation after Samuel and Trainer (1969). One gram of feces was placed into a beaker with 10ml of water. The pellets were broken up completely and the mixture was poured through standard cheesecloth into another beaker. Fecal material in the cloth was pressed with a lab spatula to remove all liquid. The liquid was then poured into a 15ml centrifuge tube and spun at 2200rpm for ten minutes in a clinical centrifuge. The supernatent was discarded and 6ml of Sheather's sugar solution (Levine et al., 1960) was added to the sediment and mixed with a spatula. Sugar solution was added to fill the tube, and the mixture was centrifuged for two minutes at 1100 rpm. After centrifugation, a positive meniscus was created on the tube by adding fresh sugar solution, and a 22mm square coverglass was placed over the top of the tube. After several minutes, the coverglass was removed and transferred to a glass slide. The entire surface of the coverglass was systematically examined for helminth eggs, larvae and coccidial oocysts with the aid of a compound microscope. Data for each sample were recorded on a standardized data sheet. Size was determined with an ocular micrometer. Relevant taxonomic keys and literature utilized in

identifying parasites included Kates and Shorb (1943), Becklund (1964), Samuel and Beaudoin (1965), Levine (1968) and Anderson and Samuel (1969).

RESULTS

Two hundred seventy fecal samples from four different areas in northeastern Illinois were examined. Examination revealed five species of nematodes and two species of coccidia. Seventy-four animals (28%) were found to carry one of more parasites which were represented by eggs, first stage larvae and oocysts (Table 1). Anatomical location of parasite in the host, number of deer infected, prevalence, intensity and size range is given for all parasites. Study wide, the trichostrongyloids showed the highest prevalence (11.5%) of all parasites found. (The designation "trichostrongyloids in the tables includes eggs of the genera Haemonchus, Ostertagia, and Trichostrongylus, and is used due to the difficulties involved in distinguishing the eggs of these three genera. The genera are closely related and species identification based on eggs alone is not feasible. Eggs seen in this study could belong to one or more of the three genera.)

TABLE 1

Parasite prevalence and intensity of Illinois urban white-tailed deer as determined by fecal flotation

Parasite	# Infected / # examined	Prevalence (%)	Intensity Range	Intensity Mean	Size (μ)
Trichostrongyloids	31/270	11.5	1-29	2.5	60-89x30-50
Oesophagostomum venulosum	5/270	2	1-4	2	70-100x36-55
Nematodirus odocoilei	6/270	2	1-9	3	140-190x53-80
Capillaria bovis	8/270	3	1-3	1.5	40-55x21-32
Parelaphostrongylus tenuis	16/270	6	1-14	3.5	190-350x10-17
Eimeria mccordocki	19/270	7	1-25	3	25-47x15-30
Eimeria madisonensis	3/270	1	1-2	1.5	17-22x17

Overall infection rate for study: 28%

Data for individual locations was separated to characterize the infections present in each. Light infections of three nematode species and one Eimeria species were found in Northwest Cook County (Table 2). Prevalence for Northwest Cook County is 25%.

Three nematode species and two species of coccidia were found in the Des Plaines area deer (Table 3). The Eimeria mccordocki infection rate is the highest for any area. Overall prevalence for the Des Plaines area is 24%.

Four species of nematodes and two species of Eimeria were discovered in Busse Woods samples (Table 4). The largest overall infection rates of this study were from the trichostrongyloid eggs (16%) and the P. tenuis larvae (14%) found in the Busse Woods samples. Prevalence for the Busse Woods collection is 41%.

Only three species of nematodes were found in the Non-Cook County samples, and low prevalences were determined for each (Table 5). The overall prevalence for Non-Cook samples is 11%.

Individual parasite prevalences for all four areas are compared in Table 6.

TABLE 2

Parasite prevalence and intensity for Northwest Cook County white-tailed deer.

Parasite	Prevalence (%)	Intensity	
		Range	Mean
Trichostrongyloids	8	1-2	1
Oesophagostomum venulosum	0	--	
Nematodirus odocoilei	6	1-9	4.5
Capillaria bovis	2	1	1
Parelaphostrongylus tenuis	0	--	
Eimeria mccordocki	10	1-5	2
Eimeria madisonensis	0	--	--

Animal sample size: 52 Infection rate: 25%
Animals found infected: 13

TABLE 3

Parasite prevalence and intensity for Des Plaines white-tailed deer.

Parasite	Prevalence (%)	Intensity	
		Range	Mean
Trichostrongyloids	10	1-4	2.5
Oesophagostomum venulosum	0	--	
Nematodirus odocoilei	2	1	1
Capillaria bovis	0	--	
Parelaphostrongylus tenuis	2	1	1
Eimeria mccordocki	12	1-25	6
Eimeria madisonensis	3.5	1-2	1.5

Animal sample size: 58 Infection rate: 24%
Animals found infected: 14

TABLE 4

Parasite prevalence and intensity for Busse Woods white-tailed deer.

Parasite	Prevalence (%)	Intensity	
		Range	Mean
Trichostrongyloids	16	1-29	3
Oesophagostomum venulosum	5	1-4	2
Nematodirus odocoilei	0	--	
Capillaria bovis	5	1-3	1.5
Parelaphostrongylus tenuis	14	1-14	4
Eimeria mccordocki	6	1-2	1
Eimeria madisonensis	1	1	1

Animal sample size: 105 Infection rate: 41%
Animals found infected: 43

TABLE 5

Parasite prevalence and intensity for Non-Cook County white-tailed deer.

Parasite	Prevalence (%)	Intensity	
		Range	Mean
Trichostrongyloids	7	1	1
Oesophagostomum venulosum	0	--	
Nematodirus odocoilei	4	1-3	2
Capillaria bovis	4	2	2
Parelaphostrongylus tenuis	0	--	
Eimeria mccordocki	0	--	
Eimeria madisonensis	0	--	

Animal sample size: 55 Infection rate: 11%
Animals found infected: 6

TABLE 6

Comparison of parasite prevalences in white-tailed deer from Northwest Cook County, Des Plaines, Busse Woods and Non-Cook County areas.

	PREVALENCE			
PARASITE	NW Cook	Des Plaines	Busse Woods	Non-Cook
Nematoda:				
Trichostrongyloids	8	10	16	7
Oesophagostomum venulosum	0	0	5	0
Nematodirus odocoilei	6	2	0	4
Capillaria bovis	2	0	5	4
Parelaphostrongylus tenuis	0	2	14	0
Protozoa:				
Eimeria mccordocki	10	12	6	0
Eimeria madisonensis	0	3.5	1	0

Parasite intensities were generally low. Most eggs, larvae, and oocysts were present in numbers less than 10. The largest intensities seemed to correspond to the areas and particular parasite species with the highest prevalences: Des Plaines, E. mccordocki; Busse Woods, trichostrongyloids and P. tenuis.

Seasonal differences in parasite prevalence and intensity were examined between all sites and within each site. Winter samples showed the greatest percentage of infections (31%), but the infection rates of summer, spring and fall were only slightly lower (26%, 27% and 25%, respectively). Intensities were uniformly low except for relatively high Eimeria oocysts numbers in spring and fall and trichostrongyloid eggs and P. tenuis larvae in isolated animals during the summer.

Parasite assemblages also changed with seasons. The greatest number of multiple parasite infections within single deer occurred in the summer and winter seasons. Trichostrongyloid eggs were found most often in spring and summer, and Capillaria bovis eggs were found in the greatest number of animals in the fall. Oocysts of the coccidia Eimeria were found most often in winter samples. Parelaphostrongylus tenuis larvae were found in fecal samples collected at all times of the year (Table 7).

TABLE 7

Seasonal parasite prevalence (%) for Illinois urban White-tailed deer.

	PREVALENCE			
PARASITE	**Summer**	**Fall**	**Winter**	**Spring**
Nematoda:				
Trichostrongyloids	19	3	7	16
Oesophagostomum venulosum	0	0	3	3
Nematodirus odocoilei	5	5	0	0
Capillaria bovis	0	8	3	1
Parelaphostrongylus tenuis	5	6	7	5
Protozoa:				
Eimeria spp.	8	3	16	4

Within locations, Northwest Cook County and Non-Cook County showed the fewest infections during all seasons with relatively little winter and spring parasite activity (Tables 8 and 11). Des Plaines and especially Busse

Woods exhibited parasite infections year-round (Tables 9 and 10). Winter and spring infections at the latter two sites are most conspicuous by their numbers when compared to the Northwest Cook and Non-Cook samples.

TABLE 8

Seasonal parasite prevalence (%) for Northwest Cook County white-tailed deer.

	PREVALENCE			
PARASITE	Summer	Fall	Winter	Spring
Trichostrongyloids	20	0	0	0
Oesophagostomum venulosum	0	0	0	0
Nematodirus odocoilei	13	7	0	0
Capillaria bovis	0	7	0	0
Parelaphostrongylus tenuis	0	0	0	0
Protozoa:				
Eimeria spp.	13	0	43	0

TABLE 9

Seasonal parasite prevalence (%) for Des Plaines white-tailed deer.

	PREVALENCE			
PARASITE	Summer	Fall	Winter	Spring
Trichostrongyloids	8	0	13	20
Oesophagostomum venulosum	0	0	0	0
Nematodirus odocoilei	0	7	0	0
Capillaria bovis	0	0	0	0
Parelaphostrongylus tenuis	0	7	0	0
Protozoa:				
Eimeria spp.	8	13	20	13

TABLE 10

Seasonal parasite prevalence (%) for Busse Woods white tailed deer.

	PREVALENCE			
PARASITE	**Summer**	**Fall**	**Winter**	**Spring**
Nematoda:				
Trichostrongyloids	29	11	11	23
Oesophagostomum venulosum	0	0	6	7
Nematodirus odocoilei	0	0	0	0
Capillaria bovis	0	11	6	3
Parelaphostrongylus tenuis	14	17	14	13
Protozoa:				
Eimeria spp.	10	0	14	3

TABLE 11

Seasonal parasite prevalence (%) for Non-Cook County white tailed deer.

	PREVALENCE			
PARASITE	**Summer**	**Fall**	**Winter**	**Spring**
Nematoda:				
Trichostrongyloids	14	0	0	14
Oesophagostomum venulosum	7	0	0	0
Nematodirus odocoilei	7	6	0	0
Capillaria bovis	0	12.5	0	0
Parelaphostrongylus tenuis	0	0	0	0
Protozoa:				
Eimeria spp.	0	0	0	0

DISCUSSION

A single published report exists concerning abomasal and intestinal helminths of white-tailed deer in Illinois (Cook et al., 1979), and no published reports are available with respect to protozoa infections. The study by Cook et al involved the necropsy of eighty-four deer and compared parasite infections in deer from northern and southern regions of the state. Cook's necropsies revealed the nematodes Gongylonema pulchrum, Apteragia odocoilei, Haemonchus contortus Nematodirus sp., Trichuris sp., and Setaria yehi, and the cestode Moniezia benedeni in the northern sample (Carroll and Jo Daviess counties). Never published separately, Schaeffler and Levine (1968) reported data indicating an approximate 50% infection rate for P. tenuis in Illinois deer. The present study found two species of nematodes not previously reported for northern Illinois deer - Oesophagostomum venulosum and Capillaria bovis.

This study is the first report of protozoans in Illinois deer. Two species of coccidia - Eimeria mccordocki and Eimeria madisonensis, were found in the samples studied.

Although not previously reported in northern Illinois, O. venulosum, C. bovis, E. mccordocki and E. madisonensis, as well as the other parasite species found in this study, are all well known and common parasites of white-tailed deer in the United States. Davidson et al. (1981), the most recent compendium of disease and parasites of white tails, lists prevalences of all these parasites in the various states where studies have been made. Particular studies which found similar assemblages include: Anderson and Samuel (1969) (samples from Pennsylvania, Texas and Wisconsin); Beaudoin, et al (1970) (samples from Pennsylvania); Samuel and Beaudoin (1965; 1966) (samples from Pennsylvania); Samuel and Trainer (1969) (samples from Wisconsin); and Prestwood et al (1973) (samples from southeastern United States, Texas and the Virgin Islands) and Cisneros (in prep.) (samples from Missouri). In most of the other studies, parasite prevalence was greater than that discovered in Illinois. Several explanations are possible. The most readily apparent is that Illinois deer are not as heavily parasitized as deer in other areas. Data from the northern study site of Cook et al. (1979), however, shows a significantly higher set of prevalence values with infection rates more similar to those found in other states than to those in the current study. This first explanation, therefore, is probably not valid.

A second possible reason for low parasite prevalence is the basic weakness of the fecal flotation procedure in indicating the full extent of an infection. Samuel and Trainer (1969) used fecal flotation to check Wisconsin deer for internal parasites and did identify eggs, larvae, and oocysts of many of the same species found in the present study.

However, their flotation findings were supplemented by necropsy recovery of parasites from deer in the study area. In most cases, necropsies revealed two to three times as many helminth infections as revealed by fecal flotation. In some cases, parasites not found in the flotation work were discovered during necropsy. Although the flotation method is the easiest and fastest way to assess the parasite assemblage within deer, necropsy of fresh kills is still the procedure of choice in order to receive the most accurate estimates of parasite prevalence and intensity. Most of the deer parasite studies previously cited were done by direct necropsy examination.

Finally, low prevalence and intensity figures of this study could have been influenced by prolonged freezing of the samples. The freezing and thawing processes can be very destructive to eggs and oocysts, and in fact, many trichostrongyloid eggs identified in this study were ruptured. Rupture most likely occurred as a result of a period of dessication prior to collection and post-collection freezing and thawing cycles before finally being examined. Ruptured eggs are often not recognizable as eggs and consequently are not counted. In fresh fecal samples, the presence of ten to twenty eggs normally does not indicate a heavy infection. However, due to potential loss of eggs, larvae and oocysts through the freezing process used in this study, infections represented by ten or more eggs, larvae or oocysts may actually indicate a heavy infection with lighter infections represented by only one or two eggs or oocysts. Those infections that are found may be perceived as lighter infections than they truly were, and some lighter or less resistant infections might be totally missed.

The last two factors described above may have contributed significantly to an apparent low parasite prevalence relative to the actual number of infected deer that may exist in the field.

Seasonal variation in parasite prevalence has been noted both between and within study sites. The comparison of overall seasonal prevalences: winter (31%), spring (27%), summer (26%) and fall (25%), indicates that the differences in overall infection rates are not statistically significant. The changing composition of parasite assemblages and the corresponding change in infection rates are noteworthy. Overall, trichostrongyloid prevalence is high in the spring and summer compared to fall and winter months (16%, 19% and 3%, 7% respectively). Eggs of the trichostrongyloid complex require warm temperatures and adequate moisture to develop - conditions most likely to occur during spring and summer. These nematodes continue to produce eggs during fall and winter, but in smaller numbers than when external conditions are favorable. The need for warm, moist conditions is reflected in the trichostrongyloid seasonal prevalence differences. During the winter, the prevalence of Eimeria spp. oocysts is also relatively high. Coccidia oocysts also

require heat and moisture to develop outside the deer, but oocysts are none-the -less released fairly continuously in the feces throughout the year. Eimeria spp. oocysts are very resistant to environmental extremes. The summer infection rate of 8% indicates a strong Eimeria presence. The winter rate of 16% shows an even greater presence which is probably related to changing habits of deer in this study. Deer typically have less food and more contact with other deer during winter due to the limited food resources. In the northern states, the deer habit of "yarding up" during the winter can lead to greatly increased contact between deer. Poor nutrition results in a reduced resistance to internal parasites. Coccidia multiply within an animal, and the parasite is spread to other deer feeding in the same area as the infected animal.

The expanded parasite assemblages found in the summer are attributable to the ideal summer growth situations for many parasite species. During winter months, the increased chance of cross transmission and the relatively debilitated state of health of deer result in expanded parasite assemblages.

In terms of each location, Eimeria spp. winter infection rate in Northwest Cook is high (43%) in spite of a small sample size. However, the samples did not indicate a high parasite intensity. The high infection rate may be due to the poor nutritional and overcrowded situation described above. The remainder of the protozoan infection record for Northwest Cook is unremarkable.

Busse Woods shows a year-round parasite presence of all but one of seven parasite species found, indicating a healthy parasite population supported by the conditions of the deer host environment.

Des Plaines and Non-Cook county areas are unremarkable in their seasonal parasite prevalences.

Based on the findings of this study, Northwest Cook county and Non-Cook county areas have the smallest parasite assemblages and the lowest parasite prevalences within their populations. Des Plaines and Busse Woods have significantly larger assemblages and prevalences. Northwest Cook and Non-Cook deer populations are described as low density and high quality with a high nutritional plane. These descriptions are in line with the results of this parasitological study. Low density and good nutrition lead to healthy deer which encounter each other only rarely. These factors are all barriers against parasite transmission and large parasite intensities. High density and poor population quality lead to populations more susceptible to cross-transmission and harboring larger numbers of parasites. Such a situation is seen in Des Plaines and Busse Woods deer.

PARASITE LIFE CYCLES AND ASSOCIATED PATHOGENICITY

Knowledge of each specific parasite's life-cycle will help to explain the influence of seasons and herd density on the occurrences of the parasite.

Ostertagia odocoilei, O. mossi, Haemonchus contortus, and Nematodirus odocoilei are all trichostrongyloids of the abomasum and share a common life cycle. Eggs are deposited in the feces and given the neccessary conditions (i.e. oxygen, moisture and warm temperatures), the eggs hatch within one to two days and the first stage larvae emerge. Still within the feces, the rhabiditiform larvae undergo two molts within the span of a few days. The infective third stage larvae then climbs onto browse where it is ingested by feeding deer. Larvae grow to adults within the gastrointestinal tract.

Pathology associated with trichostrongyloids is blood loss leading to weakness, emaciation and anemia (Davidson et al., 1981; Olsen, 1962). Van Volkenberg and Nicholson (1943) found that deer without adequate browse and under seasonally poor nutritional conditions were susceptible to starvation often accompanied by heavy parasitism, especially by trichostrongyles. Although trichostrongyles contributed to the deaths of a few deer in their study, they claimed that parasite infections were apparently unimportant among deer on ranges with sufficient food.

O. odocoilei, O. mossi and N. odocoilei are all species specific to white-tailed deer. There have been no reports of these parasites in domestic ruminants. There is no threat to humans from any of the parasites due to the very specific biology and ecology of these parasites which restricts them to inhabiting white-tailed deer.

Haemonchus contortus has been reported in cattle (Bos taurus) and sheep (Ovis aries) as well as deer. Some evidence points to the feasibility of cross-transmission between these three hosts. Successful laboratory infections have been produced with sheep being infected with deer H. contortus and vice versa (Samuel, 1968). Prestwood and Pursglove (in Davidson et al., 1981) indicate that although cross-infection has been proven possible in the laboratory and sheep, cattle and deer do all carry H. contortus, much data is still needed to determine whether the parasite infections are exchanged in nature and whether they are a pathogenic threat in all species concerned.

Capillaria bovis, a parasite of the small intestine, is part of the Trichurata and little is known about its life cycle. This species is widely distributed throughout the U. S. and infects cattle as well as deer. Its pathogenicity is unknown. Low infection intensities and low prevalences found in this and other studies (Samuel and Trainer, 1969) would seem to

indicate that this species is unimportantant pathologically to white-tailed deer. Low prevalences in deer would indicate a poor potential as parasite reservoirs for domestic ruminants such as cattle. There is no threat to humans from this parasite.

Oesophagostomum venulosum is a strongyle parasite of the colon. Infective third stage larvae develop on the ground five to six days after exposure to optimum conditions of temperature and moisture (Levine, 1968). After ingestion, larvae enter the wall of the intestine and molt to the fourth stage. Seventeen to twenty-two days after infection these larvae molt to the adult stage. No pathogenic effects have been reported for white-tailed deer. O. venulosum has been reported from a number of wild and domestic ruminants worldwide. In the U.S. this parasite has been reported in cattle, sheep, and goats (Capra hircus) (Shorb, 1939; Whitlock, 1939; Levine, 1963) where it can damage the intestinal wall. The low parasite prevalence and intensity found in this study and in others probably makes white-tailed deer populations poor infection reservoirs from which to infect other ruminants. There is no threat to humans from this parasite.

Parelaphostrongylus tenuis , the meningeal worm which inhabits the brain and spinal cord, has been of some importance in the last twenty years due mostly to its destructive effect on non-natural hosts, in particular moose (Alces alces), reindeer (Rangifer tarandus) and elk (Cervus canadensis) (Anderson, 1965; 1970; Carpenter et al., 1973; Karns, 1967; Prestwood and Smith, 1969). P. tenuis infections are acquired by ingestion of gastropod intermediate hosts containing infective third stage larvae. Eggs develop in the heart and lungs into first stage larvae which are swallowed and passed in feces. First stage larvae penetrate the foot of terrestrial snails where they grow and undergo two molts. The infective third stage larvae is acquired by deer when infected snails are accidentally ingested with browse. Third stage larvae migrate into the nervous system and develop into adult forms finally migrating into the cranium. As a natural host, the pathogenic effect of P. tenuis on the white-tailed deer appears minimal. The prevalence of this parasite can be anywhere between 5% and 86% nationwide. In experimental conditions, heavy infections are accompanied by depression, weakness, ataxia, and posterior paralysis (Davidson et al., 1981). Massive infections, with visible signs, are considered extremely rare under field conditions. P. tenuis infections have been found naturally and have been experimentally established in sheep,and goats (Anderson and Strelive, 1972; Nielson and Aftosmis, 1964). The real threat of this parasite is to other native American ungulates including moose, elk, and caribou and exotics such as fallow deer (Dama dama) Severe neurologic disorder resulting from P. tenuis infiltration of the brain has been documented in all these species There is no threat to humans from this parasite.

Protozoan infections by Eimeria mccordocki and E. madisonensis are acquired by ingestion of sporulated oocysts. Unsporulated oocysts are passed in feces and exposure to oxygen and moisture outside the host leads to sporulation. Heavy infections are marked by diarrhea, sometimes leading to emaciation, apathy, passage of blood and ultimately death (Davidson, et al., 1981). Evidence suggests infection intensity declines with the deer's age due to acquired resistance resulting from previous infections. As previously discussed, crowded conditions and poor nutrition contribute to Eimeria infections. Anderson and Samuel (1969) report that both E. mccordocki and E. madisonensis are found only in white tailed deer . These parasite are therefore very species specific and there is little chance of transmission to domestic ruminants and no threat to humans.

SUMMARY AND CONCLUSIONS

The low prevalences and low intensities indicate that none of the deer in this study were heavily parasitized, nor do they show a threat to the general deer population in terms of parasitic infection. In the most general terms, the results of this study can be seen as an indicator that deer of the four study areas, Northwest Cook County, Des Plaines, Busse Woods, and Non-Cook County, are relatively healthy. The deer of Des Plaines and Busse Woods may not be as healthy as those of Northwest Cook and Non-Cook, but this phenomenon may be attributable to the differences in density and nutritional quality of their respective areas. Studies such as those by the Southeast Cooperative Wildlife Disease Study (Eve and Kellogg, 1977) and Demarais, et al. (1983) are attempting to construct deer herd health indices which utilize intensity of parasite infections to show a positive correlation to deer density. The aim is to create an index of correlations so that by checking a relatively small sample of the herd on a regular basis and comparing the parasite count to the established index it is possible to determine the density and health of the herd. This study in no way approaches that level of sophistication, but it does serve to inform the investigator of parasites present in the deer and lend support to any previously suspected trends in the population.

FINAL COMMENTS ON THE EFFECTIVENESS OF THIS STUDY

All samples were processed as one gram of feces so that intensity is measured as number of parasite eggs per one gram of feces. The term "intensity" is relatively useless in terms of parasite eggs and fecal flotations as a whole since adult parasites are capable of producing many eggs. Eggs counted from one animal for a single species of parasite may have been created by one or by a dozen nematodes. There are no rules concerning numbers of males and females; only dissection and extraction can determine exact parasite population numbers. Fecal flotation is useful as a tool to establish parasite assemblages , but not intensities. The exception is when the number of eggs, larvae or oocysts is so large that a heavy infection can be deduced. Such was not the case in this study. There were no indications of heavy or massive infections in any of the samples examined. Samples which did contain parasites contained too few specimens to allow estimation of the number of adult parasites involved.

More infections might have been detected and the accuracy of this study increased if the samples had been stored in 10% formalin rather than frozen for one to three years. Experience shows the condition of parasite eggs and oocysts is significantly better after storage in formalin than after freezing.

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Appendix 1
Infection Data by Specimen
Northwest Cook County

T = Trichostrongyloid
N = Nematodirus
O = Oespohagostomum
C = Capillaria
P = Parelaphostrongylus
E = Eimeria

Data #	UDS #	Season	Confirmed Infection	General Infection Information
1	44	W	x	E (micropyle) 28-30 x 15-20 μ, 5 found
2	510	W	x	E (micropyle) 35 x 25 , 1 found
3	43	W		
4	59	W		
5	71	W		
6	520	W		
7	991	F		
8	473	F		
9	912	F		
10	537	W	x	Coccidia egg, 35 x 15 μ, 1 found
11	998	F		
12	963	F		
13	979	F	x	N egg, 155-170 x 75 μ 9 found
14	983	F	x	Dark bioperculate eggs, 40 x 25 μ, 1 found (possible C)
15	454	F		
16	474	F		
17	855	S		
18	428	F		
19	417	F		
20	439	F		
21	003	F		
22	006	F		
23	329	F	x	T egg (ruptured) 80 x 45 μ, 1 found
24	866	S		
25	846	S	x	Large, dark coccidian (micropyle present) 50 x 30 μ , 1 found (sheep?); T egg, 75 x 50 μ, 1 found; N egg, 165 x 75 μ, 1 found
26	256	S		
27	252	S		
28	844	S	x	E 38 x 25 , 1 found; egg like structure, 35 x 20 μ , 6 - 8 found; N egg (deflated) 160 x 75 μ, 2 found; N egg (whole), 155 x 80 μ, 1 found
29	814	S		
30	842	S		
31	813	S		
32	856	S	x	T egg (deflated), 80 x 45-50 μ, 2 found
33	165	Sp		
34	109	Sp		
35	157	Sp		
36	812	S		
37	816	S	x	T egg, 70 x 40 μ, 1 found

38	838	S		
39	135	Sp		
40	835	S		
41	125	Sp		
42	712	Sp		
43	130	Sp		
44	728	Sp		
45	193	Sp		
46	754	Sp		
47	164	Sp		
48	810	S	x	E. (micropyle) 28-30 x 20-22 μ, 2 found
49	100	Sp		
50	103	Sp		
51	677	Sp		
52	105	Sp		

Appendix 2
Infection by specimen
Des Plaines

T = Trichostrongyloid
N = Nematodirus
O = Oespohagostomum
C = Capillaria
P = Parelaphostrongylus
E = Eimeria

Date #	UDS #	Season	Confirmed infection	General infection information
53	903	S	x	E, 22 x 17μ, 1 found
54	906	S		
55	890	S		
56	894	S		
57	806	S	x	T, yellow/silver color, ruptured, 75-90 x 30-35μ, 3 found
58	986	F		
59	830	S		
60	911	F	x	E, silver, rough, micropyle, 35-47 x 25-30μ, 15 found
61	280	S		
62	249	S		
63	824	S		
64	825	S		
65	276	S		
66	289	S		
67	422	F	x	N, ruptured, 190 x 75μ, 1 found
68	443	F	x	P, kinked tail, 225 x 10-15μ, 1 found
69	442	F		
70	448	F		
71	404	F	x	E, micropyle with yellow interior, 35 x 25μ, 1 found
72	392	F		
73	873	S		
74	917	F		
75	455	F		
76	478	F		
77	415	F		
78	689	Sp		
79	185	Sp		
80	649	Sp		
81	353	F		
82	688	Sp		
83	344	F		
84	369	F		
85	213	Sp	x	E, 30-35 x 22-25μ, 25 found
86	679	Sp		
87	181	Sp		
88	676	Sp	x	E, micropyle, 35 x 27μ, 2 found; E, round, 17 x 17μ, 2 found; T, 75-80 x 35-45μ, 4 found
89	172	Sp	x	T, 1 found
90	182	Sp		
91	174	Sp		
92	175	Sp		
93	153	Sp		
94	572	W		
95	041	W		
96	083	W		
97	601	W		
98	666	Sp		

99	542	W	x	T, 3 found
100	496	W	x	T, ruptured, 75 x 35$_{4}$, 2 found
101	568	W		
102	552	W		
103	569	W		
104	544	W	x	E, micropyle, 25 x 20$_{4}$, 1 found
105	062	W		
106	584	W		
107	585	W		
108	583	W	x	E, 30 x 20-30$_{4}$, 2 found
109	149	Sp	x	E, 25 x 20$_{4}$, 1 found; T, ruptured, 70 x 30$_{4}$, 1 found
110	549	W		

Appendix 3
Infection by Specimen
Busse Woods

T = Trichostrongyloid
N = Nematodirus
O = Oespohagostomum
C = Capillaria
P = Parelaphostrongylus
E = Eimeria

Data #	UDS #	Season	Confirmed infection	General infection information
111	840	S		
112	310	S		
113	239	S	x	T, 82 x 35μ, 1 found; T 65 70 x 40μ, 1 found
114	836	S	x	P, kinked tail, 225-240 x 10μ, 14 found; T, silver gray, 80-85 x 40-45μ, 2 found
115	274	S	x	E, round, 17 x 17μ, 1 found
116	299	S		
117	826	S	x	E, 25 x 20μ, 1 found; T, 70 x 37μ, 1 found
118	892	S		
119	260	S		
120	275	S		
121	886	S		
122	895	S	x	T, ruptured, 80 x 50μ, 2 found
123	802	S		
124	815	S		
125	871	S		
126	888	S		
127	322	S	x	T, 75 x 35-40μ, 1 found
128	2072	W		
129	829	S	x	P, 255 x 10μ, 3 found
130	854	S		
131	2063	W	x	T, ruptured, 60 x 35μ, 1 found; E, micropyle, 30-35 x 25μ, 2 found
132	2064	W		
133	831	S		
134	905	S	x	T, ruptured, 75-85 x 35-42μ, 29 found; T larvae, 6 found; P, kinked tail, 190-225 x 10-15μ, 6 found
135	2049	W		
136	2056	W		
137	557	W	x	T, 80-85 x 40-45μ, 2 found
138	2033	W	x	E, micropyle, 25-27 x 15μ, 1 found
139	2070	W	x	P, 225-250 x 10μ, 7 found; P, (better condition) 350 x 17μ, 1 found; E, 25 x 20μ, 1 found
140	2073	W		
141	030	W		
142	036	W		
143	528	W		
144	602	W		
145	024	W		
146	2020	W	x	O, 70 x 55μ, 1 found; T, 70 x 35μ, 1 found; P, 1 found
147	2027	W		
148	2028	W		
149	2038	W	x	P, 235-250 x 10-15μ, 3 found
150	2059	W		
151	2055	W	x	C, 50-55 x 22-25μ, 3 found
152	2075	W	x	E, 25 x 15μ, 1 found
153	2022	W		
154	2037	W	x	C, 55 x 27μ, 1 found; O, 85-90 x 40μ, 2 found

155	042	W		
156	046	W	x	T, ruptured, 75-85 x 40-42 q, 2 found
157	2046	W	x	E, 25 x 17 a, 1 found; T, 70 x 35 q, 1 found
158	2050	W	x	P, 200-210 x 10-12 a, 2 found
159	038	W		
160	078	W		
161	031	W		
162	051	W		
163	023	W		
164	025	W	x	P, 250-300 x 15 a, 1 found
165	067	W		
166	082	W		
167	2048	W		
168	2117	Sp	x	T, ruptured, 80 x 37 a, 1 found
169	2081	Sp		
170	2086	Sp	x	T, 75 x 32 a, 1 found
171	627	Sp	x	T, ruptured, 75-80 x 32-40 q, 2 found
172	638	Sp		
173	620	Sp		
174	660	Sp	x	T, ruptured, 60 x 35 a, 1 found
175	2095	Sp	x	P, 225 x 15 q, 2 found
176	2114	Sp	x	P, 235-240 x 12-15 q, 2 found
177	2099	Sp		
178	2105	Sp		
179	644	Sp		
180	2125	Sp		
181	2120	Sp	x	P, 220 x 10 q, 2 found
182	2123	Sp	x	P, 205-220 x 10 q, 5 found
183	694	Sp	x	T, 75-85 x 35-45 q, 2 found
184	797	Sp		
185	225	Sp	x	T, 85 x 30 q, 2 found
186	748	Sp		
187	098	Sp	x	O, 90-100 x 47-55 q, 4 found
188	191	Sp		
189	115	Sp	x	O, 98 x 46 a, 2 found
190	150	Sp	x	C, 51 x 25 q, 1 found
191	187	Sp		
192	695	Sp		
193	2005	F	x	T, 70-76 x 37 a, 2 found
194	970	F		
195	331	F	x	T, 87 x 42 a, 1 found
196	378	F		
197	949	F		
198	801	Sp		
199	2006	F	x	C, 53 x 25 q, 1 found
200	2008	F		
201	177	Sp		
202	188	Sp		
203	171	Sp		
204	176	Sp	x	T, 77-79 x 35 q, 2 found; E, 30 x 23 a, 1 found
205	470	F	x	P, 253 x 12 a, 1 found
206	475	F		
207	346	F		
208	2010	F		
209	004	F		
210	2013	F	x	P, 270-276 x 10-13 a, 3 found
211	336	F		
212	2011	F		
213	351	F	x	C, 51 x 25 a, 1 found
214	357	F	x	P, 253-287 x 16 q, 3 found
215	2014	F		

Appendix 4
Infection by Specimen
Non-Cook

T = Trichostrongyloid
N = Nematodirus
O = Oespohagostomum
C = Capillaria
P = Parelaphostrongylus
E = Eimeria

Data #	UDS #	Season	Confirmed infection	General infection information
216	975	F		
217	976	F		
218	400	F		
219	877	S		
220	907			
221	960	F		
222	430	F		
223	449	F		
224	416	F		
225	431	F	x	C, 40-46 x 21-23μ, 2 found
226	460	F	x	N, 150-160 x 70-75μ, 3 found
227	956	F		
228	350	F		
229	425	F		
230	374	F		
231	396	F		
232	526	W		
233	553	W		
234	001	W		
235	2024	W		
236	387	F		
237	536	W		
238	002	W		
239	081	W		
240	504	W		
241	507	W		
242	514	W		
243	541	W		
244	765	Sp		
245	796	Sp		
246	080	W		
247	673	Sp		
248	713	Sp	x	T, 72 x 40μ, 1 found
249	757	Sp	x	T, 75 x 35μ, 1 found
250	202	Sp		
251	742	Sp		
252	818	S		
253	878	S		
254	635	Sp		
255	647	Sp		
256	811	S		
257	819	S	x	T, 72 x 30μ, 1 found; N, 140 x 53μ, 1 found
258	827	S		
259	875	S		
260	847	S		
261	870	S		
262	114	Sp		

Addendum

The original sample inventory submitted for flotation included 274 fecal groups. The final number examined was 270. From the original list, six samples were exempted per your request. Three samples, 963 (Northwest Cook), 78 and 826 (Busse Woods) were found in the sample bags and were analyzed in place of three samples, 969 (Northwest Cook), 73 and 876 (Busse Woods) listed on the inventory, but not found in the bags. Two additional samples (877 and 907, Non-Cook) found in the bags but not listed in the inventory were analyzed.